

INTRODUCTION

1. INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of the TRMM Flight Operations Plan (FOP) is to serve as a comprehensive baseline reflecting how the space and ground segments operate and interact to achieve the mission objectives. Instrument science objectives, observatory subsystem and instrument design characteristics, mission operations philosophy, and ground systems architecture all serve as a foundation for the development of the FOP. The plan provides a basis for the development of detailed flight and ground system operating procedures.

System overviews and detailed system descriptions are provided where appropriate. The major emphasis of the TRMM FOP is on the Normal Mission Operations phase with less detail on the Pre-launch Planning and Testing, Launch and In Orbit Checkout (L&IOC) Operations, and End of Life (EOL) Ocean Disposal phases.

The TRMM FOP encompasses operational plans, scenarios, time-lines, interfaces, and configurations pertaining to the TRMM ground and flight support as perceived by the Flight Operations Team (FOT). The TRMM FOP will also serve as a comprehensive training tool for future FOT members.

1.2 DOCUMENT ORGANIZATION

The TRMM FOP is comprised of twelve separate sections. A brief description of each follows:

- Section-1: Provides a brief introduction including document purpose, scope, and organization, and a referenced document list.
- Section-2: Provides a mission overview including a description of the mission objectives and the four mission phases. In addition, a brief description of the TRMM spacecraft, instruments, and ground system is provided.
- Section-3: Describes the Pre-launch Planning and Testing, Launch and In Orbit Checkout (L&IOC) Operations, Normal Mission Operations, and End of Life (EOL) Ocean Disposal phases. Prelaunch details include a description of planned spacecraft and Ground Data System (GDS) testing. L&IOC details include a description of the H-II Expendable Launch Vehicle (ELV), Launch operations, and an overview of the TRMM deployment and initialization activities. Normal operations provides a high-level description of mission planning and scheduling, a real-time operations overview, and a 24-hour mission profile. Additionally, a brief description of the End of Life Ocean Disposal is provided.

INTRODUCTION

- Section-4: Provides a detailed description of the various spacecraft subsystems and spacecraft operations for normal mission operations.
- Section-5: Provides details on the operation of the science instrument complement. Specific operations such as instrument calibrations and maneuvers are described.
- Section-6: Provides details of real-time flight operations with an emphasis on the Mission Operations Center (MOC).
- Section-7: Provides details of off-line operations including mission planning and scheduling, command load generation, Project Data Base maintenance, and trend and performance analysis.
- Section-8: Provides a description of key operations support elements including the NASA Communications (Nascom), Space Network (SN), Ground Network/Deep Space Network/Santiago (AGO) Tracking Station/Wallops Flight Facility (WFF), Flight Dynamics Facility (FDF), and the Sensor Data Processing Facility (SDPF).
- Section-9: Describes the TRMM Science Data and Information System (TSDIS), NASDA Earth Observation Center (EOC), Langley Research Center (LaRC), and Marshall Space Flight Center (MSFC) operations including real-time operations, remote terminal access, and production data processing.
- Section-10: Describes FOT training methodologies including use of the TRMM Test and Training Simulator (TTS) and Spacecraft Test and Training Facility (STTF).
- Section-11: Provides a description of the Communications and Broadcasting Engineering Test Satellite (COMETS) experiment operations.
- Section-12: Provides a description of the TRMM Flight Operations Team.

1.3 REFERENCED DOCUMENTS

The TRMM Flight Operations Plan has been developed using a combination of mission, spacecraft, science, and ground system documentation, in addition to meeting with subsystem and instrument engineers, science representatives, and system developers. Specific documents referenced in this process include the following:

- a. Tropical Rainfall Measuring Mission Flight Data System User's Guides, October 1993
- b. TRMM Reaction Control Subsystem Mission Requirements, February 1993
- c. TRMM Reaction Control Subsystem Specification, October 1992

INTRODUCTION

- d. TRMM Reaction Control Subsystem Critical Design Audit (CDA),
September 1993
- e. Flight Dynamics Division Generic Data Product Formats Interface Control
Document, 553-FDD-91/028), June 1991
- f. Interface Control Document Between the Tropical Rainfall Measuring Mission
(TRMM) Mission Operations Center and the Onboard Computer Software Tools,
510-4ICD/0393, September 1993
- g. Recommendation for Space Data System Standards: Telecommand (Part 2.1)
Command Operations Procedures, Red Book, Issue 4, January 1991
- h. Overview of the CCSDS Telecommand Standard, September 1992
- i. Recommendation for Space Data System Standards: Telecommand (Part 2) Data
Routing Service Architectural Specification, Blue Book, Issue 1, January 1987
- j. Tropical Rainfall Measuring Mission (TRMM) Observatory to Space flight
Tracking and Data Network Radio Frequency Interface Control Document,
TRMM-490-086, April 1993
- k. Data Format Control Document Between the Goddard Space Flight Center
Payload Operations Control Centers and the Network Control Center Data
System, 530-DFCD-NCCDS/POCC, March 1992
- l. Space Network User's Guide for Real-time Operations, 534-UGD-SN-RTOPS,
March 1993
- m. Mission Critical Design Review, October 1993
- n. Detailed Mission Requirements, Issue 2, June 1994
- o. X-Ray Timing Explorer/Tropical Rainfall Measuring Mission Attitude Control
Electronics Hardware Critical Design Review, March 1993
- p. X-Ray Timing Explorer/Tropical Rainfall Measuring Mission Attitude Control
Electronics Critical Design Review, March 1993
- q. Users Spacecraft Clock Calibration System (USCCS) User's Guide, 531-TR-001,
October 1991
- r. User's Guide for the NASA Standard TDRSS User Transponder, The Second
Generation (Issue A), November 1987

INTRODUCTION

- s. Deployables/High Gain Antenna Critical Design Review, December 1993
- t. CERES Operations Concept Document, TRMM-490-118, Signature, May 1994
- u. TRMM/CERES Instrument Interface Control Document (ICD), TRMM-490-021,
- v. CERES Critical Design Review (CDR), December 1993
- w. LIS Operations Concept Document, TRMM-490-083, Signature, May 1994
- x. LIS Critical Design Review (CDR), March 1, 1994
- y. TRMM/VIRS Interface Control Document, TRMM-490-024, Signature, December 1993
- z. VIRS Critical Design Review (CDR), CDRL#016, January 1994
- aa. TMI Critical Design Review (CDR) Data Package, September 1993
- bb. System Requirements Specification Description document for the TRMM PSIB, February 1994
- cc. Power Subsystem Critical Design Review (CDR), August 1993
- dd. TRMM Operations Concept Document, TRMM-490-080, July 1993
- ee. TRMM and Communications and Broadcast Engineering Test Satellite (COMETS) Operations Concept Document, Draft, April 1994
- ff. Electrical Subsystem Critical Design Review (CDR), August 1993
- gg. TRMM/TMI Interface Control Document, TRMM-490-023, April 1993
- hh. Data Format Control Document (DFCD) for the Project Database (PDB) Supporting the Tropical Rainfall Measuring Mission (TRMM) Mission Operations Center (MOC), 510-4DFC/0194. July, 1994.
- ii. Transportable Payload Operations Control Center (TPOCC) Orbital Signature Analyzer (TOSA) System Requirements Specification, 511-4SRD/0194, February, 1994.
- jj. Tropical Rainfall Measuring Mission Telemetry and Command Handbook. Document, TRMM-490-137, May, 1994.
- kk. TRMM Observatory to MOC Interface Test Plan, TRMM-500-190, July 1994

- ll. Space Views System Requirements, April 1992
- mm. User's Guide for the Generic Spacecraft Analysts Assistant (GenSAA) for TPOCC, February 1994, DSTL-93-014
- nn. TRMM System Requirements Specification Volume-1 Mission Operations Center, May 1994, 510-4SRD/0393
- oo. TRMM System Requirements Specification Volume-2 Test and Training Simulator, May 1994, 510-4SRD/0393
- pp. TRMM Test and Training Simulator Functional Requirements Document, February 1994, TRMM-500-154
- qq. Recommendation for Space Data System Standards: Telecommand, Part 2-1, Command Operation Procedures, Red Book, Issue-4, January, 1991
- rr. Attitude Control Subsystem, Critical Design Review, July, 1993
- ss. Attitude Control Electronics, Critical Design Review, October, 1993
- tt. Attitude Control System, Software Critical Design Review, October, 1993
- uu. Engine/Valve Driver, Critical Design Review, December, 1993
- vv. ACS Failure Detection and Correction Guide, Draft, December, 1993
- ww. ICD between the TRMM MOC and Flight Dynamics Facility (FDF), Revision 0, June 1994
- xx. Specification for TRMM Solar Array Deployment & Drive System, January, 1994
- yy. TRMM Electrical Subsystem Interface Control Document (ICD), Revision A, January 19, 1995, TRMM-733-059
- zz. TRMM Spacecraft Software On-board Telemetry Monitor and Response Specification, December 9, 1994, TRMM-490-138
- aaa. TRMM Launch and In-Orbit Checkout (L&IOC) Plan, July, 1996, TRMM-490-396
- aab. TRMM MOC Systems User's Guide; Volume-1 and Volume-2, April, 1996, 511-4SUG/0895